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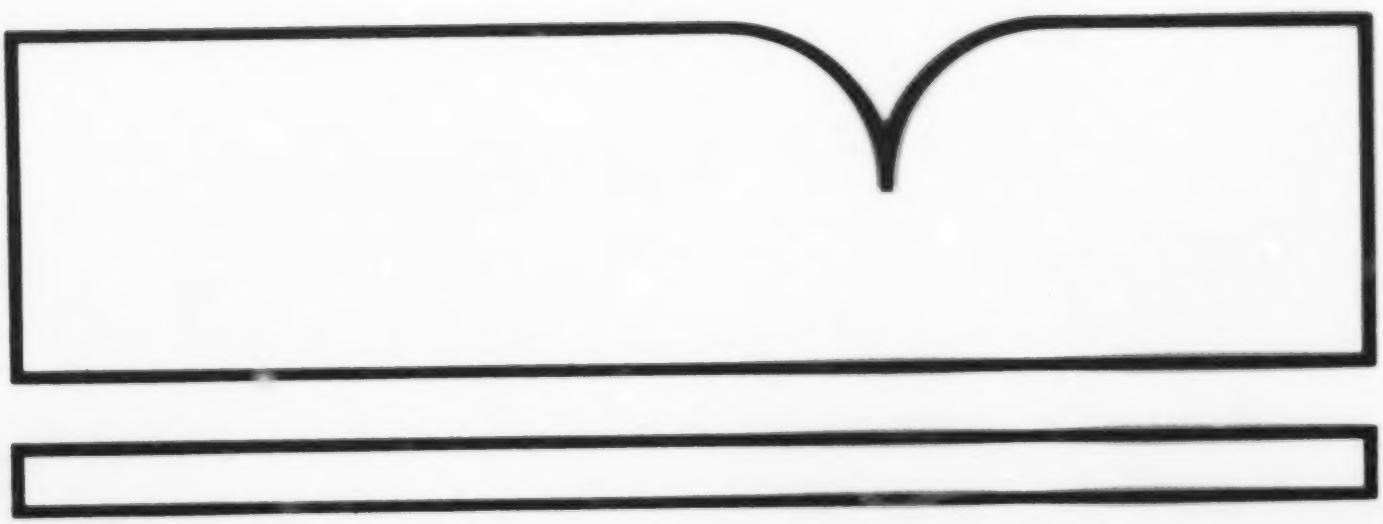

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Effects of Ground ULV Applications of Fenthion on Estuarine Biota III. Response of Caged Pink Shrimp and Grass Shrimp[1]

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ABSTRACT

Estuarine grass shrimp (*Palaemonetes pugio*) and pink shrimp (*Penaeus duorarum*) were deployed in floating cages to determine if fenthion, in an actual-use application in the field, affected shrimp survival. After four ultra-low-volume ground applications (equivalent to 11g/ha or 0.01 lb/acre) to control salt marsh mosquitoes, deaths of caged grass shrimp or pink shrimp were not attributed to fenthion exposure. Suspect causes of reduced survival of shrimp include both low salinity and dissolved oxygen, daily excursions in water temperature, and stresses due to handling, acclimation, and confinement. Initial fenthion concentrations in seawater were sometimes within the range expected to kill shrimp in 48-h and 96-h laboratory exposures; however, pesticide concentrations were not sustained long enough to kill caged shrimp in the field. No signs of fenthion poisoning were observed among any of the caged shrimp.

INTRODUCTION

Grass shrimp (*Palaemonetes pugio*) are abundant omnivores that consume inorganic and organic detritus (Odum and Heald 1972, Williams 1984), and are food for predaceous fishes. Both larvae and adults inhabit estuarine waters of low to intermediate salinity (1 to 15‰). *P. pugio* has been successfully used in acute and chronic toxicity tests in the laboratory (Tyler-Schroeder 1979).

The pink shrimp (*Penaeus duorarum*) is one of three species which comprise virtually the whole penaeid shrimp fishery in the Gulf of Mexico, the most valuable fishery in the United States (Osborn et al. 1969, Anonymous 1977, Anonymous 1984). Although pink shrimp are found in the northwestern Atlantic and throughout the Gulf of Mexico, they have centers of abundance off North Carolina, southeastern to northeastern Florida, and southeastern Mexico (Allen et al. 1980, Costello and Allen 1970, Osborn et al. 1969, Williams 1984). Pink shrimp spawn and their progeny develop to the post-larval stage offshore. Post-larvae enter estuarine nursery grounds where most grow into juveniles, and a few into adults (Costello and Allen, 1970). The juveniles migrate offshore to deeper water where they mature and spawn (Costello and Allen 1970, Renfro and Brusher 1982, Williams 1984).

The mosquitocide fenthion, characteristic of organophosphate insecticides, is highly toxic to grass shrimp and pink shrimp. Borthwick et al. (1985) determined the acute toxicity of fenthion to both *P. pugio* and *P. duorarum*. The 48-h LC50's (static) were 4.7 µg/l and 0.25 µg/l, respectively. The 48- and 96-h LC50's (flow-through) were 0.22 µg/l and 0.11 µg/l for pink shrimp.

Because grass shrimp and pink shrimp are extremely sensitive to short-term exposures of fenthion, they were chosen as experimental animals for four field applications of this mosquitocide. In addition, both species were readily obtainable, amenable to caging, and indigenous to estuarine habitats in the vicinity of the study areas.

METHODS AND MATERIALS

Adult grass shrimp were netted from shallow grass beds at Pirates Cove (near the reference site) on Santa Rosa Sound 3 to 10 days prior to deployment and acclimated to site conditions. Generally, physical conditions were similar at collection and deployment sites.

Local bait dealers provided adequate numbers of pink shrimp for caged studies. Animal quality at each bait shop tended to

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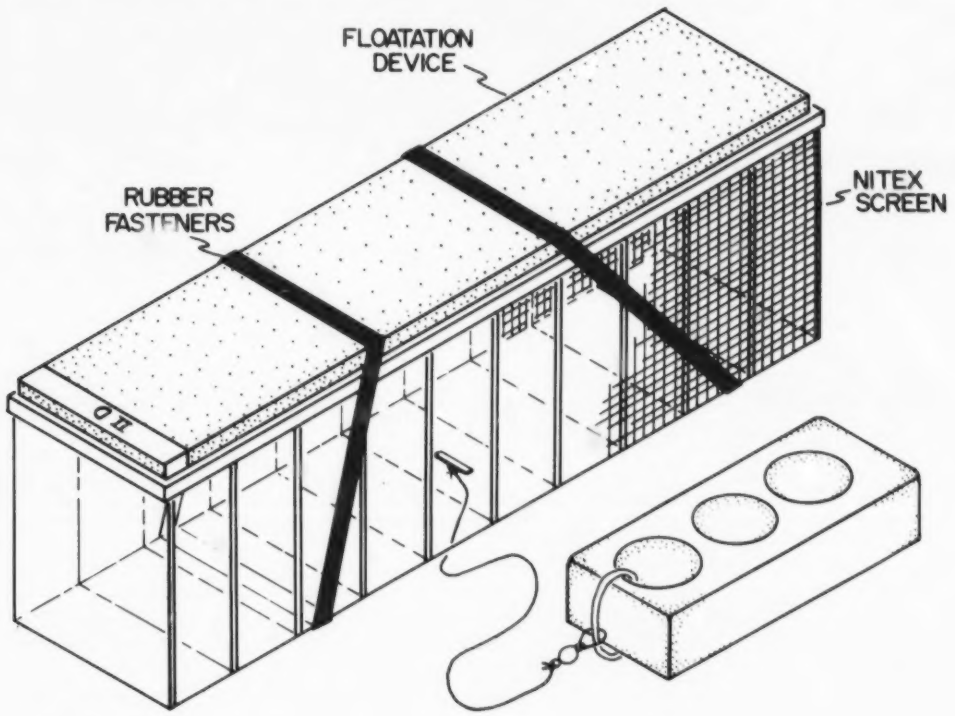

Fig. 1. Shrimp cage design.

vary due to holding conditions, time since delivery, and handling stress. We purchased juvenile and young adult pink shrimp as soon as practicable following their delivery to the dealer. Once procured, a slow flow (1 to 4 l/h) of lower salinity (<10 $^{0}/_{00}$) seawater or site water was supplied to the shrimp to acclimate them to deployment site salinities, since bait dealers usually hold shrimp at higher salinities (>25 $^{0}/_{00}$). When necessary, ice was added to the seawater to decrease or maintain the temperature. Both shrimp species were identified taxonomically according to descriptions in Anderson (1962) and Williams (1965) and measured before or after the caged field exposure. Mean lengths (rostrum to telson) of pink shrimp tested in the 4 sprays ranged from 59 mm to 88 mm. The mean length of grass shrimp was 20 mm taken from Spray 4 only.

The design of the pink shrimp and grass shrimp cages (Figure 1) was similar to that used by Tagatz et al. (1974). Each rectangular, 10-compartment cage had a lid, bottom, two smaller sides, and nine partitions of clear acrylic plastic (3 mm) and two larger sides of Nitex® nylon screen (1.8 mm mesh). The rimmed lid with attached Styrofoam® float was secured to the cage with rubber bands. Dimensions of the grass shrimp cage were 26 cm × 6 cm × 5 cm; of the pink shrimp cage, 52 cm × 12 cm × 13 cm. Individual cages were each tethered to a brick with braided nylon cord to maintain their position.

Before fenthion application, the shrimp were placed randomly in the cages and compartments. Survival was determined at 12-, 24-, and 48-h post-spray intervals, dead shrimp were counted and removed, and survivors were observed for signs of poisoning. Both species were deployed for each of the four fenthion sprays, except that no grass shrimp were caged for Spray 2 on 10 May 83. Pre-spray grass shrimp exposures were conducted at both sites prior to Spray 1, and pre-spray pink shrimp exposures at both sites were conducted prior to Spray 4.

Table 1. Survival (%) of caged grass shrimp (*Palaemonetes pugio*) following truck-mounted ULV adulticide applications (11 g/ha or 0.01 lb/acre) of fenthion.

Spray No. And Date	Site	Percentage Post-Spray 12	Survival Exposure 24	Through Time, h 48	Individuals n =	Temp. °C	Salinity °/₀₀
Pre-Spray	Reference	100	100	100	30	[b]—	—
Control	Site 1	100	100	100	40	[b]—	—
29 March 1983							
Spray 1	Reference	100	100	[a]—	120	24-25	6
5 May 1983	Site 1	98	96	[a]—	120	26	3-6
Spray 2	No caged grass shrimp deployed for this exposure						
10 May 1983							
Spray 3	Reference	94	86	72	120	28-30	12
13 June 1983	Site 1	97	96	87	120	27-31	10
Spray 4	Reference	93	90	89	120	30-32.5	11-14
11 July 1983	Site 1	99	98	99	120	27.5-32.5	7-14

[a]No observations made at this interval.
[b]No physical measurements made at this interval.

Table 2. Survival (%) of caged pink shrimp (*Penaeus duorarum*) following truck-mounted ULV applications (11 g/ha or 0.01 lb/acre) of fenthion.

Spray No. And Date	Site	Percentage Post-Spray 12	Survival Exposure 24	Through Time, h 48	Individuals n =	Temp. °C	Salinity °/₀₀
Spray 1	Reference	87	87	[a]—	120	24-25	6
5 May 1983	Site 1	82	69	[a]—	120	26	3-6
Spray 2	Reference	87	87	80	40	25-28	7-8
11 May 1983	Site 1	70	65	60	40	25-27	6-8
Spray 3	Reference	82	76	72	50	28-30	12
13 June 1983	Site 1	66	64	60	50	27-31	10
Pre-Spray	Reference	[a]—	100	87	90	28-31	10-14
Control	Site 1	[a]—	97	93	90	27-29	5-12
21 June 1983							
Spray 4	Reference	89	84	82	80	30-32.5	11-14
11 July 1983	Site 1	97	94	92	120	27.5-32.5	7-14

[a]No observations made at this interval.

RESULTS AND DISCUSSION

After four ground ultra-low-volume (ULV) sprays, no death of caged grass shrimp or pink shrimp was attributable to fenthion. Further, no behavioral signs of poisoning were observed among the groups of exposed shrimp. Although survival at sprayed and reference sites differed (Tables 1 and 2) frequently, the survival was lower at the reference site than at the treated site, which supports the assumption that small differences (20% or less) in survival were due to local temperature excursions, low salinities and dissolved oxygen, handling and confinement stress, or other physical factors at the study sites. No statistical analyses were employed to substantiate these apparent differences.

Initial fenthion concentrations in seawater were sometimes within the range shown to kill shrimp in 48-h and 96-h acute laboratory exposures, but were not sustained at lethal levels for sufficient time periods to cause mortality in the caged shrimp at the ULV sprayed sites.

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